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UPPER WINDS MEASURED AT M/Y IMPERIA, MIRABELLA BAY, CRETE

By J. DURWARD, M.A.

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UPPER WINDS MEASURED AT M/Y IMPERIA, MIRABELLA BAY, CRETE.

By J. DURWARD, M.A.

In August, 1934, a pilot balloon station was established near M/Y *Imperia*, on the shores of Mirabella Bay, Crete. The site is far from ideal and it was realized that the results of pilot balloon observations made according to the single theodolite method might be seriously affected by the up and down currents which were known to occur in the vicinity. For example, during certain types of weather, the downward component of north-westerly winds is so strong that water is raised in the form of spray to a height of 50–100 ft. It was thought, however, that if ascents were made in the early morning about sunrise that the air would be sufficiently stratified to permit of the single theodolite method being used and it is thought that this is to a great extent true; but the demands of trans-Mediterranean air services have led to ascents being done at other times of the day and it has been noticed that in many cases these results are undoubtedly misleading and a potential source of danger to aircraft, especially those of low air speed. The object of the present note is twofold—

(*a*) to give an analysis of one year's pilot balloon observations in Crete (morning observations only) and,

(*b*) to discuss the reliability of the morning and afternoon observations.

General Features of Pressure Distribution.—During the months December to April, Crete lies in the centre of a high-pressure ridge which separates low-pressure areas over the Levant and the western Mediterranean. Although the prevailing wind is north-westerly, the passage of numerous depressions across the Mediterranean causes the wind to blow with considerable frequency from other directions, notably from S. to SW. During the rest of the year the low-pressure area over Iraq and the Persian Gulf extends to the Aegean Sea, and especially during the period June to September, the wind near Crete rarely blows from any other direction than NW.

Site.—A map showing the immediate surroundings of M/Y *Imperia* and the pilot balloon station is shown on p. 3. It will be noted that to the south-west, Mount Oxia rises to a height of 1,852 ft. and to the north-west, Mount Pyrgos to a height of 1,223 ft. The area subject to the violent squalls already referred to above is indicated on the map. If a section is drawn north-west from the pilot balloon station it may be seen from the resulting profile that

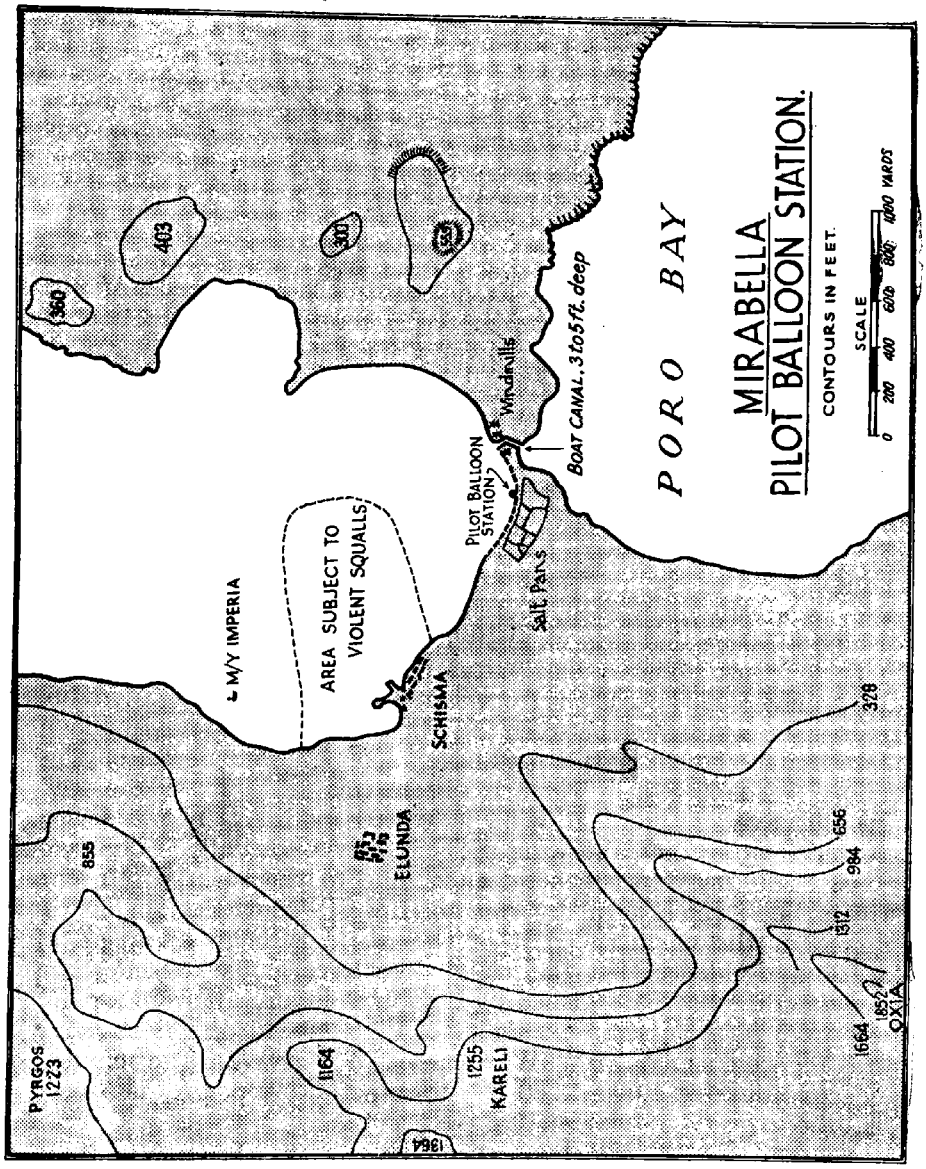

MIRABELLA
PILOT BALLOON STATION.
CONTOURS IN FEET.
SCALE
0 200 400 600 800 1000 YARDS
PORO BAY
BOAT CANAL, 3 to 5 ft. deep
Windmills
PILOT BALLOON STATION
Salt Pans
AREA SUBJECT TO VIOLENT SQUALLS
M/Y IMPERIA
SCHISMA
ELUNDA
KARELI
OXIA
PYRGOS
1223
1164
1255
1364
855
1664
1852
1312
984
656
328
360
403
300

FIG. 1

the physical features of the neighbourhood are very favourable to the establishment of a quasi-permanent eddy similar to that indicated on the left-hand side of the diagram (Fig. 2) taken from Georgii's " Flugmeteorologie ".*

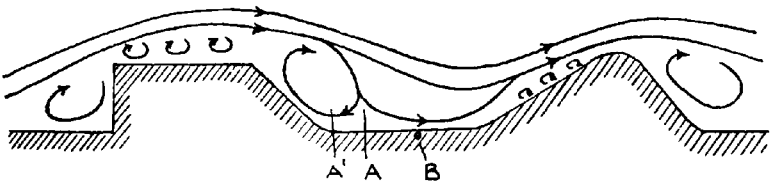


FIG. 2

In this case the area liable to violent squalls would be A A' and and at a station B there would be a considerable reduction of wind velocity at low levels as shown by the separation of the stream lines.

Reliability of the Observations (early morning).—The only method available of assessing the value of the observations is to compare the winds measured by pilot balloons with those calculated from the pressure gradient. Owing to the situation of Crete this is not very easy because the number of barometer readings received from surrounding stations is very small and some of them appear unreliable. Also, as already mentioned, Crete often lies in the centre of a wedge of high pressure and it is impossible to calculate the gradient wind in these cases. The isobaric situation was, however, sufficiently determined on 204 occasions from September, 1934, to August, 1935, to justify a comparison between the winds computed by pilot balloon observation and from the pressure gradient. The result of this comparison is shown in Table I. From this table, it will be seen that the average gradient wind is veered in direction and has a greater velocity than the wind measured by pilot balloon observations. This may be a general effect due to the island itself, the stream lines which normally run north-west – south-east being refracted at the northern coast of the island through an angle of 20°–25°. Evidence that the island does have a marked effect on the wind direction is furnished by reports from aircraft from a point just south of the eastern extremity of Crete—wind directions being often reported as SW. or WSW. when WNW. to NW. are anticipated and conditions at 1,000–1,500 ft. are sometimes reported as " very disturbed ".

It will also be seen that on the 204 occasions when the gradient wind was measurable, there were 52 occasions when there was a large difference between the gradient wind either in direction or

*GEORGII, W.; Flugmeteorologie. Leipzig, Akademische Verlagsgesellschaft M.B.H., 1927, p. 121.

TABLE I

Month	Difference. Gradient—Measured wind		No. of occasions	Remarks	No. of cases of marked difference
1934	°	m.p.h.			
September	+25	+ 2·0	20	Very good agreement—wind directions nearly all between 320°–360°.	1
October	+11	+ 3·3	15	Very good agreement	1
November	+ 6	+ 4·5	13	Very good agreement—large part of the average difference due to one observation.	1
December	+13	+ 3·6	19	As for November, 1934	2
1935					
January	+13	+ 7·4	17	The average difference of 7·4 largely made up of three discrepancies of 25, 21, 25 m.p.h.	4
February	+ 7	+13·5	17	Agreement between the winds measured at 1,000–2,000 ft. very poor—in most cases the gradient wind was measured between 3,000 and 5,000 ft.	11
March	+29	+13·0	9	Agreement poor, especially as regards velocity ..	5
April	+11	+ 3·8	14	Agreement good	2
May	+ 8	+ 7·6	18	Agreement poor, but wind measured at 3,000–5,000 ft. in many cases in agreement with the gradient.	10
June	+19	+ 5·7	15	As for May, 1935	4
July	+15	+ 2·9	22	Agreement good on the whole but many cases when the wind 0–1,500 ft. was very local.	2
August	+19	+ 2·0	25	As for July, 1935	9

velocity, but chiefly in velocity. These 52 occasions are accounted for as follows :—

Winds	*Total No. of discrepancies chiefly in velocity*	*Total No. of observations*
(*a*) WNW.–N.	17	166
(*b*) SSW.–W.	9	18
(*c*) SSE.–SSW.	5	19
(*d*) Easterly	1	1
(*e*) Bearing no relation to the gradient at 1,000 or 1,500 ft., generally SE.–SW. with a north-westerly gradient.	17	..
(*f*) North-easterly with a south-westerly gradient.	1	..
(*g*) Velocities obviously in error due to "vortex" in bay.	2	..
Total	52	204

Winds under categories (*e*) and (*g*) could have been included under (*a*), and (*f*) under (*b*), but they have been considered of sufficient interest to warrant separate consideration.

With the prevailing north-westerly wind there is, therefore, about one day in ten on which the measured wind is too light for the gradient. With winds between SSW. and W. there are large discrepancies on about 50 per cent of occasions ; the average difference being about 22 m.p.h. In other words, on bad days the velocity of the wind measured by pilot balloon is about one-third of the gradient wind.

It is possible, therefore, that the chief reason why the winds at M/Y *Imperia* do not agree with the gradient wind is a purely local one. The lightness of the winds is due to the observation point being just outside the region marked "area of dangerous squalls" on Fig. 1, i.e. in such an area as is typified by A–B in Fig. 2. There seems no doubt that the 17 cases under (*e*) are connected with the quasi-permanent eddy. Instead of the true wind being measured, a return current similar to that indicated between A and A′ in Fig. 2 is measured and the true wind is finally encountered between 2,000 and 4,000 ft. The same applies to (*f*) and (*g*). In the latter case the balloon was seen by the observer to be caught "in a vortex over the bay".

To sum up: the winds measured at 1,000–2,000 ft. at M/Y *Imperia* about 0400 G.M.T. daily are not seriously in error on three days out of four but they are normally 15°–25° backed from the gradient wind and 2–5 m.p.h. lighter. On one day in four they are considerably in error due to the presence of an eddy on the lee side of Mount Oxia and Mount Pyrgos, but on about 70 per cent of such occasions the gradient wind is encountered at a height between 3,000 and 5,000 ft.

Reliability of the Observations (afternoon).—The occasions on which the gradient wind could be computed from the 1200 or 1800 G.M.T. chart and on which pilot balloon ascents were made twice daily were then examined and the result is briefly as follows.

Of 100 occasions there were 42 on which the morning ascent was better than the afternoon, 41 on which the ascents were equally good and 17 on which a definite change in distribution had occurred and the afternoon ascent was better than the morning. In other words, nothing is gained by making afternoon ascents on 83 per cent of days. Of the remaining 17 per cent of occasions the change would be obvious to a single observer—e.g. passage of a depression, large increase or decrease in surface wind obviously not due to local causes.

It has not been thought necessary to give any details of the discrepancies between gradient and measured afternoon winds. Generally speaking, the measured winds are " backed " from the gradient direction and of lesser speed. The velocities measured in the afternoon are much more irregular than the morning velocities, obviously due to the existing large vertical currents. The presence of the eddy in the bay during the afternoon is shown on about 11 per cent of occasions as compared with about 9 per cent in the morning.

Discussion of Results.—The results of the ascents are given in the form recommended by the International Commission for Air Navigation (Tables II–VII). In addition, monthly diagrams (Figs. 3–8) have been constructed of wind velocity and direction frequency vectors. As the wind at Crete for a considerable portion of the year blows steadily from a north-westerly point, this method of representing wind direction should prove very suitable and a glance at the diagrams will show that for the observations available, this is so.

The chief features of interest in the wind distribution are :—

(*a*) The remarkable constancy of the wind during June, July and August. In these months the constancy at 3,000 ft. varies from 94 per cent to 97 per cent, the wind circulation being part of that round the low-pressure area in Iraq and the Persian Gulf.

(*b*) January and December are the only months in which the resultant wind direction is south of west.

(*c*) The constancy of the wind in February is remarkable. The same result has emerged from a study of the winds at Aboukir, for at this station for 1930–4 the constancy figure for February for 6,000 ft. is 61 per cent compared with 34 per cent in January and 39 per cent in March.

(*d*) In the period January–May there is a gradual increase from the surface to 7,000 ft. In June to October there is very little increase after 3,000 ft.

(*e*) The wind at 3,000 ft. is strongest in July.

TABLE II—FREQUENCY SUMMARY OF SURFACE AND UPPER WINDS

Speed.	0500 JANUARY, 1935 N.	NE.	E.	SE.	S.	SW.	W.	NW.	0500 FEBRUARY, 1935 N.	NE.	E.	SE.	S.	SW.	W.	NW.
	SURFACE (3 ft. above ground) 0–3 m.p.h. 12. Total cases, 27								SURFACE (3 ft. above ground) 0–3 m.p.h. 15. Total cases, 24							
m.p.h.																
4–15 ..	..	..	..	1	2	2	..	5	1	..	..	..	1	..	2	3
16–31 ..	1	..	..	..	2	1	..	1	1	..	..	..	..	1	..	..
32–47 ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
48 and over ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Mean wind speed.	16·0	..	..	7·0	17·0	13·7	..	13·8	16·0	..	..	..	9·0	16·0	11·5	8·7
TOTAL ..	1	..	..	1	4	3	..	6	2	..	..	..	1	1	2	3
	1,500 ft. 0–3 m.p.h. 4. Total cases, 27.								1,500 ft. 0–3 m.p.h. 3. Total cases, 24.							
m.p.h.																
4–15 ..	1	1	1	1	2	3	..	1	2	..	..	..	1	2	8	3
16–31 ..	1	..	..	..	4	1	2	3	1	..	..	..	..	..	2	2
32–47 ..	..	..	..	..	1	..	1	..	..	..	..	..	..	..	..	..
48 and over ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Mean wind Speed.	11·5	4·0	4·0	4·0	20·4	10·7	22·7	17·7	13·3	..	..	..	11·0	5·0	12·6	17·6
TOTAL ..	2	1	1	1	7	4	3	4	3	..	..	..	1	2	10	5
	3,000 ft. 0–3 m.p.h. 5. Total cases, 27.								3,000 ft. 0–3 m.p.h. 1. Total cases, 23.							
m.p.h.																
4–15 ..	1	..	1	..	..	5	3	1	..	..	..	1	..	3	4	2
16–31 ..	1	..	..	1	4	1	1	3	..	..	..	..	..	..	3	4
32–47 ..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	1	2
48 and over ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1
Mean wind speed.	14·0	..	7·0	23·0	23·7	11·7	14·7	19·7	..	..	..	7·0	..	17·5	17·9	25·7
TOTAL ..	2	..	1	1	4	6	4	4	..	..	..	1	..	4	8	9
	6,000 ft. 0–3 m.p.h. 0. Total cases, 14.								6,000 ft. 0–3 m.p.h. 0. Total cases, 16.							
m.p.h.																
4–15 ..	..	..	..	..	3	3	2	..	..	..	..	..	..	..	5	1
16–31 ..	..	..	..	..	1	3	1	..	..	..	..	..	..	..	..	4
32–47 ..	..	..	..	..	1	..	..	..	..	..	..	..	..	1	2	2
48 and over ..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	..	..
Mean wind Speed.	..	..	..	..	18·0	19·8	15·7	..	..	..	..	..	..	51·0	18·9	25·0
TOTAL ..	..	..	..	..	5	6	3	..	..	..	..	..	..	2	7	7
	10,000 ft. 0–3 m.p.h. 0. Total cases, 7.								10,000 ft. 0–3 m.p.h. 0. Total cases, 6.							
m.p.h.																
4–15 ..	..	..	..	..	1	1	..	..	1	..	..	..	..	..	..	..
16–31 ..	..	..	..	..	..	..	2	..	..	..	..	..	..	..	2	1
32–47 ..	..	..	..	..	..	2	..	..	..	..	..	..	..	..	..	1
48 and over ..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..	1
Mean wind speed.	..	..	..	..	10·0	35·7	27·5	..	13·0	..	..	..	..	..	24·0	37·0
TOTAL ..	..	..	..	..	1	4	2	0	1	..	..	..	..	..	2	3

NOTE.—The frequency numbers are actual numbers and not percentages.

TABLE III—FREQUENCY SUMMARY OF SURFACE AND UPPER WINDS

Speed.	0050 MARCH, 1935 N.	NE.	E.	SE.	S.	SW.	W.	NW.	0500 APRIL, 1935 N.	NE.	E.	SE.	S.	SW.	W.	NW.
	SURFACE (3 ft. above ground) 0–3 m.p.h. 9. Total cases, 15.								SURFACE (3 ft. above ground) 0–3 m.p.h. 14. Total cases, 27.							
m.p.h.																
4–15 ..	..	..	..	..	..	1	2	..	1	..	..	..	..	2	4	2
16–31 ..	..	..	..	..	..	..	1	2	..	..	..	..	..	1	1	2
32–47 ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
48 and over ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Mean wind speed.	..	..	..	..	..	8·0	13·7	16·0	8·0	..	..	..	..	12·7	11·8	17·0
TOTAL ..	..	..	..	..	..	1	3	2	1	..	..	..	..	3	5	4
	1,500 ft. 0–3 m.p.h. 5. Total cases, 15.								1,500 ft. 0–3 m.p.h. 7. Total cases, 27.							
m.p.h.																
4–15 ..	1	..	..	..	1	1	1	2	..	1	1	..	2	1	2	4
16–31 ..	..	..	..	..	..	..	1	2	..	..	..	..	1	..	1	5
32–47 ..	..	..	..	..	..	..	..	1	1	..	..	..	..	..	..	1
48 and over ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Mean wind speed.	7·0	..	..	..	9·0	15·0	15·5	21·4	39·0	5·0	6·0	..	12·0	10·0	10·3	21·8
TOTAL ..	1	..	..	..	1	1	2	5	1	1	1	..	3	1	3	10
	3,000 ft. 0–3 m.p.h. 0. Total cases, 14.								3,000 ft. 0–3 m.p.h. 3. Total cases, 26.							
m.p.h.																
4–15 ..	1	1	1	1	..	..	..	5	1	1	1	..	..	1	4	5
16–31 ..	..	..	..	..	..	1	1	3	..	..	..	..	..	1	1	3
32–47 ..	..	..	..	..	..	..	..	..	3	..	..	..	..	1	..	1
48 and over ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Mean wind Speed.	13·0	10·0	5·0	5·0	..	20·0	21·0	15·3	32·0	4·0	7·0	..	..	24·0	10·4	16·4
TOTAL ..	1	1	1	1	..	1	1	8	4	1	1	..	..	3	5	9
	6,000 ft. 0–3 m.p.h. 0. Total cases, 8.								6,000 ft. 0–3 m.p.h. 0. Total cases, 20.							
m.p.h.																
4–15 ..	1	..	..	..	1	..	..	..	1	..	..	..	1	..	3	2
16–31 ..	1	2	..	..	..	1	2	..	2	..	..	..	..	1	6	2
32–47 ..	..	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..
48 and over ..	..	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..
Mean wind speed.	13·0	21·5	..	..	7·0	18·0	16·5	..	35·0	..	..	..	4·0	30·0	18·7	18·0
TOTAL ..	2	2	..	..	1	1	2	..	5	..	..	..	1	1	9	4
	10,000 ft. 0–3 m.p.h. 0. Total cases, 4.								10,000 ft. 0–3 m.p.h. 0. Total cases, 6.							
m.p.h.																
4–15 ..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	..	1
16–31 ..	..	..	..	..	..	2	1	1	..	..	..	..	..	..	1	1
32–47 ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	1
48 and over ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Mean wind speed.	..	..	..	..	..	25·0	17·0	27·0	..	..	..	..	..	9·0	33·5	24·3
TOTAL ..	..	..	..	..	..	2	1	1	..	..	..	..	..	1	2	3

NOTE.—The frequency numbers are actual numbers and not percentages.

TABLE IV—FREQUENCY SUMMARY OF SURFACE AND UPPER WINDS

Speed.	0500 MAY, 1935 N.	NE.	E.	SE.	S.	SW.	W.	NW.	0300–0400 JUNE, 1935 N.	NE.	E.	SE.	S.	SW.	W.	NW.
	SURFACE (3 ft. above ground) 0–3 m.p.h. 20. Total cases, 26.								SURFACE (3 ft. above ground) 0–3 m.p.h. 7. Total cases, 16.							
m.p.h.																
4–15 ..	1	..	..	3	1	..	1	..	..	..	..	..	2	..	4	1
16–31 ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	1
32–47 ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
48 and over ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Mean wind speed.	15·0	..	..	11·7	15·0	..	12·0	..	..	..	..	..	6·5	..	12·6	17·0
TOTAL ..	1	..	..	3	1	..	1	..	..	..	..	..	2	0	5	2
	1,500 ft. 0–3 m.p.h. 9. Total cases, 26.								1,500 ft. 0–3 m.p.h. 2. Total cases, 16.							
m.p.h.																
4–15 ..	3	..	..	..	2	2	1	5	..	..	..	..	..	..	4	3
16–31 ..	..	..	..	..	1	..	..	3	..	..	..	..	..	..	1	5
32–47 ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1
48 and over ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Mean wind speed.	9·3	..	..	..	13·3	6·0	5·0	15·9	..	..	..	..	..	..	9·4	20·4
TOTAL ..	3	..	..	..	3	2	1	8	..	..	..	..	..	..	5	9
	3,000 ft. 0–3 m.p.h. 4. Total cases, 26.								3,000 ft. 0–3 m.p.h. 1. Total cases, 16.							
m.p.h.																
4–15 ..	6	..	1	..	2	2	..	2	2	..	..	..	..	..	1	3
16–31 ..	3	..	..	..	..	..	..	2	2	..	..	..	..	..	..	5
32–47 ..	1	..	..	..	..	1	..	1	1	..	..	..	..	..	..	1
48 and over ..	..	..	..	..	1*	..	..	..	..	..	..	..	..	..	..	..
Mean wind speed.	14·3	..	6·0	..	35·7	14·7	..	20·8	21·5	..	..	..	..	..	12·0	20·3
TOTAL ..	10	..	1	..	3	3	..	5	5	..	..	..	..	..	1	9
	6,000 ft. 0–3 m.p.h. 0. Total cases, 17.								6,000 ft. 0–3 m.p.h. 1. Total cases, 15.							
m.p.h.																
4–15 ..	4	1	..	3	1	1	1	..	..	2	..	..	..	..	..	3
16–31 ..	2	1	..	..	..	1	..	..	4	2	..	..	..	..	..	2
32–47 ..	..	..	..	..	..	..	1	1	..	..	..	..	..	..	..	1
48 and over ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Mean wind speed.	14·0	18·5	..	6·3	13·0	15·5	21·0	35·0	19·7	15·7	..	..	..	..	..	17·7
TOTAL ..	6	2	..	3	1	2	2	1	4	4	..	..	..	..	..	6
	10,000 ft. 0–3 m.p.h. 0. Total cases, 6.								10,000 ft. 0–3 m.p.h. 0. Total cases, 4.							
m.p.h.																
4–15 ..	..	..	1	..	..	..	..	..	..	..	..	1	..	1	1	..
16–31 ..	2	..	..	..	1	1	..	1	..	1	..	..	..	..	..	..
32–47 ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
48 and over	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Mean wind speed.	19·5	..	7·0	..	30·0	24·0	..	19·0	..	17·0	..	10·0	..	9·0	13·0	..
TOTAL ..	2	..	1	..	1	1	..	1	..	1	..	1	..	1	1	..

NOTE.—The frequency numbers are actual numbers and not percentages.

* High velocity confirmed by Imperial Airways aircraft ground speed May 1, 1935.

TABLE V—FREQUENCY SUMMARY OF SURFACE AND UPPER WINDS

Speed.	0300–0400 July, 1935*								0330–0350 AUGUST, 1935							
	N.	NE.	E.	SE.	S.	SW.	W.	NW.	N.	NE.	E.	SE.	S.	SW.	W.	NW.
	SURFACE (3 ft. above ground) 0–3 m.p.h. 6. Total cases, 22.								SURFACE (3 ft. above ground) 0–3 m.p.h. 9. Total cases, 27.							
m.p.h.																
4–15 ..	..	..	..	1	..	..	6	7	1	..	..	1	2	..	6	2
16–31 ..	1	..	..	..	..	1	..	..	..	..	..	..	..	..	3	3
32–47 ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
48 and over ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Mean wind speed.	26·0	..	..	4·0	..	18·0	9·3	6·3	4·0	..	..	4·0	4·5	..	15·1	17·0
TOTAL ..	1	..	..	1	..	1	6	7	1	..	..	1	2	..	9	5
	1,500 ft. 0–3 m.p.h. 1. Total cases, 22.								1,500 ft. 0–3 m.p.h. 1. Total cases, 25.							
m.p.h.																
4–15 ..	2	..	..	..	..	..	2	7	3	..	..	..	..	..	3	5
16–31 ..	..	..	..	..	..	..	..	9	1	..	..	..	..	..	1	11
32–47 ..	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..
48 and over ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Mean wind speed.	13·0	..	..	..	..	..	7·5	19·6	13·0	..	..	..	..	..	13·0	18·4
TOTAL ..	2	..	..	..	..	..	2	17	4	..	..	..	..	..	4	16
	3,000 ft. 0–3 m.p.h. 0. Total cases, 22.								3,000 ft. 0–3 m.p.h. 0. Total cases, 26.							
m.p.h.																
4–15 ..	3	..	..	..	..	..	1	1	2	..	..	..	..	..	1	4
16–31 ..	4	..	..	..	..	..	..	6	9	..	..	..	..	..	1	5
32–47 ..	4	..	..	..	..	..	..	2	1	..	..	..	..	..	..	3
48 and over ..	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..
Mean wind speed.	24·3	..	..	..	..	..	10·0	28·3	21·0	..	..	..	..	..	17·0	20·2
TOTAL ..	11	..	..	..	..	..	1	10	12	..	..	..	..	..	2	12
	6,000 ft. 0–3 m.p.h. 1. Total cases, 21.								6,000 ft. 0–3 m.p.h. 1. Total cases, 24.							
m.p.h.																
4–15 ..	6	1	..	..	..	..	..	..	4	1	..	..	..	1	..	2
16–31 ..	8	..	..	..	..	..	..	2	9	..	..	..	..	..	1	..
32–47 ..	1	..	1	..	..	..	..	1	3	..	..	..	..	..	1	1
48 and over ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Mean wind speed.	17·4	6·0	35·0	..	..	..	..	27·3	21·1	15·0	..	..	..	11·0	27·0	22·3
TOTAL ..	15	1	1	..	..	..	..	3	16	1	..	..	..	1	2	3
	10,000 ft. 0–3 m.p.h. 3. Total cases, 6.								10,000 ft. 0–3 m.p.h. 1. Total cases, 6.							
m.p.h.																
4–15 ..	..	1	..	..	..	..	..	..	..	..	..	..	..	1	..	1
16–31 ..	..	..	..	..	..	..	1	1	..	..	..	..	..	..	2	..
32–47 ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	..
48 and over ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Mean wind speed.	..	5·0	..	..	..	..	18·0	31·0	..	..	..	..	..	4·0	27·7	10·0
TOTAL ..	..	1	..	..	..	..	1	1	..	..	..	..	..	1	3	1

NOTE.—The frequency numbers are actual numbers and not percentages.

* No ascents after the 22nd.

TABLE VI—FREQUENCY SUMMARY OF SURFACE AND UPPER WINDS

Speed.	0500 SEPTEMBER, 1934–5 N.	NE.	E.	SE.	S.	SW.	W.	NW.	0430–0530 OCTOBER, 1934–5 N.	NE.	E.	SE.	S.	SW.	W.	NW.
	SURFACE (3 ft. above ground) 0–3 m.p.h. 21. Total cases, 54.								SURFACE (3 ft. above ground) 0–3 m.p.h. 26. Total cases, 57.							
m.p.h.																
4–15 ..	1	..	..	1	1	3	7	15	3	..	1	2	2	2	10	6
16–31 ..	1	..	..	..	..	..	2	1	..	..	1	..	1	1	..	2
32–47 ..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..
48 and over ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Mean wind speed.	12·5	..	..	5·0	9·0	7·3	16·4	11·9	9·7	..	16·0	4·5	9·0	14·0	8·6	12·4
TOTAL ..	2	..	..	1	1	3	10	16	3	..	2	2	3	3	10	8
	1,500 ft. 0–3 m.p.h. 7. Total cases, 54.								1,500 ft. 0–3 m.p.h. 6. Total cases, 57.							
m.p.h.																
4–15 ..	1	..	1	..	1	..	10	11	5	1	..	1	7	2	2	19
16–31 ..	2	..	..	..	1	..	..	18	3	..	..	..	1	3	1	5
32–47 ..	..	..	..	..	..	..	..	2	..	..	..	..	..	1	..	..
48 and over ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Mean wind speed.	15·0	..	9·0	..	11·5	..	7·9	18·5	11·7	5·0	..	7·0	9·9	19·0	12·0	11·7
TOTAL ..	3	..	1	..	2	..	10	31	8	1	..	1	8	6	3	24
	3,000 ft. 0–3 m.p.h. 3. Total cases, 54.								3,000 ft. 0–3 m.p.h. 4. Total cases, 56.							
m.p.h.																
4–15 ..	1	..	..	1	2	..	4	10	8	1	..	..	2	4	6	15
16–31 ..	8	..	..	..	1	..	3	15	4	..	..	..	1	2	..	5
32–47 ..	2	..	..	..	..	..	..	4	..	..	..	..	..	1	..	2
48 and over ..	..	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..
Mean wind speed.	20·9	..	..	7·0	12·7	..	13·6	21·0	17·0	4·0	..	..	14·7	19·4	9·3	15·1
TOTAL ..	11	..	..	1	3	..	7	29	13	1	..	..	3	7	6	22
	6,000 ft. 0–3 m.p.h. 2. Total cases, 44.								6,000 ft. 0–3 m.p.h. 3. Total cases, 46.							
m.p.h.																
4–15 ..	6	3	1	..	2	1	1	5	5	5	..	..	..	1	8	5
16–31 ..	12	1	..	..	1	1	2	2	6	..	..	..	1	1	6	3
32–47 ..	2	..	..	..	..	..	1	..	..	1	..	..	..	..	..	..
48 and over ..	..	..	..	..	..	..	..	1	1	..	..	..	..	..	..	..
Mean wind speed.	19·1	13·5	4·0	..	..	10·5	23·0	19·9	19·7	13·3	..	..	23·0	18·5	14·3	12·7
TOTAL ..	20	4	1	..	3	2	4	8	12	6	..	..	1	2	14	8
	10,000 ft. 0–3 m.p.h. 0. Total cases, 13.								10,000 ft. 0–3 m.p.h. 0. Total cases, 23.							
m.p.h.																
4–15 ..	4	..	..	1	1	..	..	1	5	4	..	..	..	..	1	3
16–31 ..	..	1	..	..	..	..	3	1	1	..	..	..	..	2	2	2
32–47 ..	..	..	..	..	..	..	..	..	..	..	..	..	..	2	1	..
48 and over ..	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..
Mean wind speed.	13·3	18·0	..	8·0	6·0	..	24·7	28·0	10·3	10·0	..	..	..	28·0	25·2	16·2
TOTAL ..	4	1	..	1	1	..	3	3	6	4	..	..	..	4	4	5

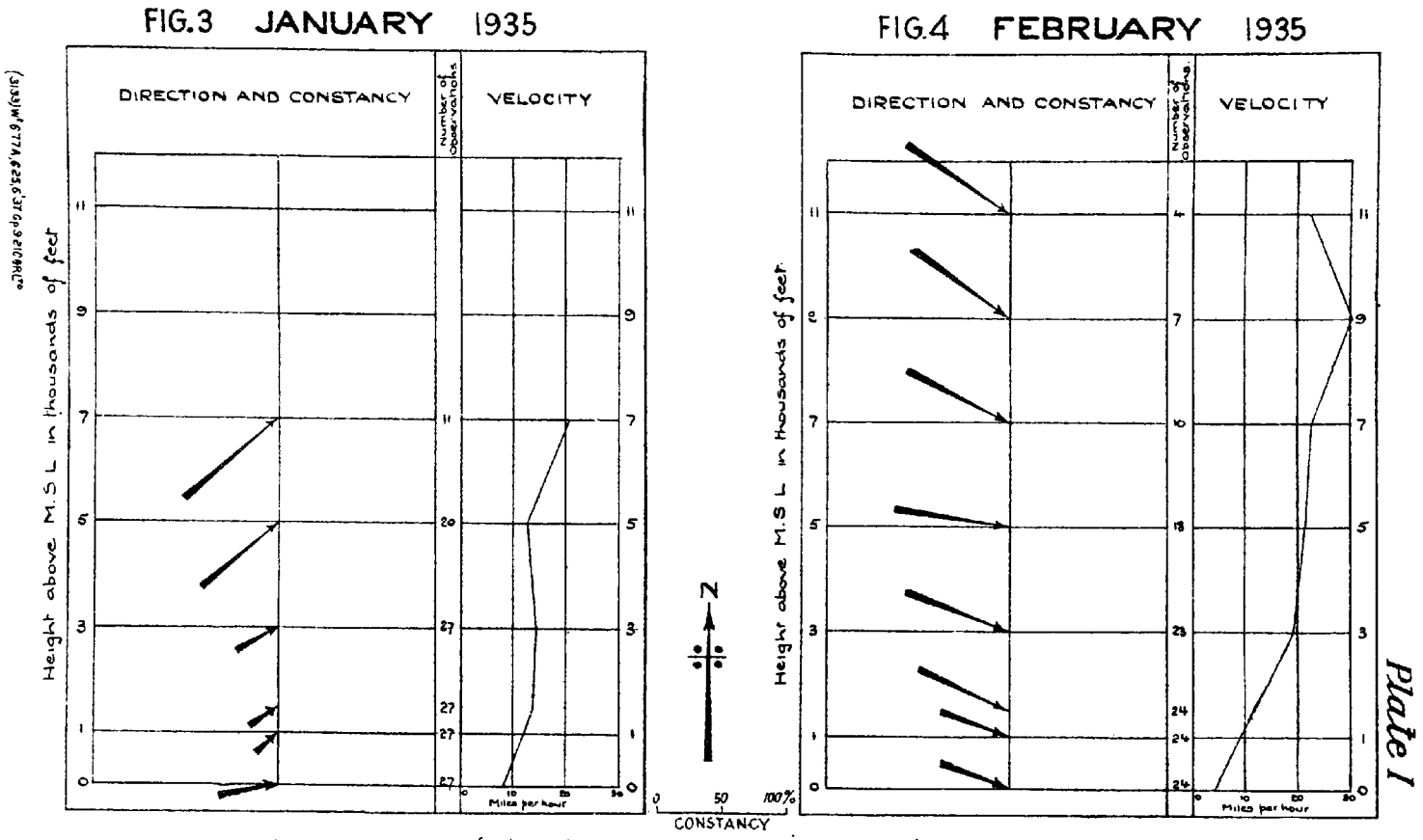
NOTE.—The frequency numbers are actual numbers and not percentages.

TABLE VII—FREQUENCY SUMMARY OF SURFACE AND UPPER WINDS

Speed.	0430–0500 NOVEMBER, 1934–5								0500 DECEMBER, 1934–5							
	N.	NE.	E.	SE.	S.	SW.	W.	NW.	N.	NE.	E.	SE.	S.	SW.	W.	NW.
	SURFACE (3 ft. above ground) 0–3 m.p.h. 26. Total cases, 46.								SURFACE (3 ft. above ground) 0–3 m.p.h. 20. Total cases, 46.							
m.p.h.																
4–15 ..	3	1	..	..	4	..	2	4	2	..	..	..	3	7	4	10
16–31 ..	2	..	..	..	1	..	..	3	..	..	..	..	..	..	..	..
32–47 ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
48 and over ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Mean wind speed.	13·4	8·0	..	..	11·4	..	6·5	13·0	10·5	..	..	..	..	11·3	11·3	10·2
TOTAL ..	5	1	..	..	5	..	2	7	2	..	..	..	3	7	4	10
	1,500 ft. 0–3 m.p.h. 10. Total cases, 46.								1,500 ft. 0–3 m.p.h. 3. Total cases, 46.							
m.p.h.																
4–15 ..	6	..	..	1	4	1	2	10	1	..	1	3	7	4	9	6
16–31 ..	..	..	..	..	2	..	..	7	3	..	..	1	1	..	2	4
32–47 ..	..	..	..	..	..	..	..	3	..	..	..	..	1	..	..	..
48 and over ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Mean wind speed.	9·7	..	..	5·0	14·0	12·0	8·0	18·5	17·3	..	5·0	8·3	15·8	9·3	12·8	15·9
TOTAL ..	6	..	..	1	6	1	2	20	4	..	1	4	9	4	11	10
	3,000 ft. 0·3 m.p.h. 7. Total cases, 45.								3,000 ft. 0–3 m.p.h. 5. Total cases, 46.							
m.p.h.																
4–15 ..	8	..	..	..	1	3	2	5	3	..	..	..	2	5	7	3
16–31 ..	4	..	..	2	..	..	1	10	1	..	..	2	3	1	4	4
32–47 ..	..	..	..	..	1	..	..	1	..	..	..	..	..	1	3	2
48 and over ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Mean wind speed.	12·5	..	..	20·5	25·5	6·3	15·0	19·7	15·5	..	..	21·0	17·4	14·3	19·1	21·0
TOTAL ..	12	..	..	2	2	3	3	16	4	..	..	2	5	7	14	9
	6,000 ft. 0–3 m.p.h. 2. Total cases, 29.								6,000 ft. 0–3 m.p.h. 1. Total cases, 28.							
m.p.h.																
4–15 ..	1	1	..	..	1	2	2	6	2	2	..	..	..	2	6	..
16–31 ..	2	..	..	1	..	1	4	3	..	1	..	1	..	5	5	..
32–47 ..	2	..	..	..	..	..	..	..	..	..	..	..	..	..	2	1
48 and over ..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Mean wind speed.	..	8·0	..	23·0	4·0	15·7	19·2	13·5	15·0	14·0	..	22·0	..	17·1	19·2	37·0
TOTAL ..	6	1	..	1	1	3	6	9	2	3	..	1	..	7	13	1
	10,000 ft. 0–3 m.p.h. 0. Total cases, 6.								10,000 ft. 0–3 m.p.h. 0. Total cases, 6.							
m.p.h.																
4–15 ..	2	..	..	..	..	..	1	..	..	..	..	..	..	..	2	..
16–31 ..	..	..	..	..	..	1	1	1	..	..	..	..	..	2	2	..
32–47 ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
48 and over ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Mean wind speed.	11·5	..	..	..	..	28·0	16·0	30·0	..	..	..	..	..	29·0	19·3	..
TOTAL ..	2	..	..	..	..	1	2	1	..	..	..	..	..	2	4	..

NOTE.—The frequency numbers are actual numbers and not percentages.

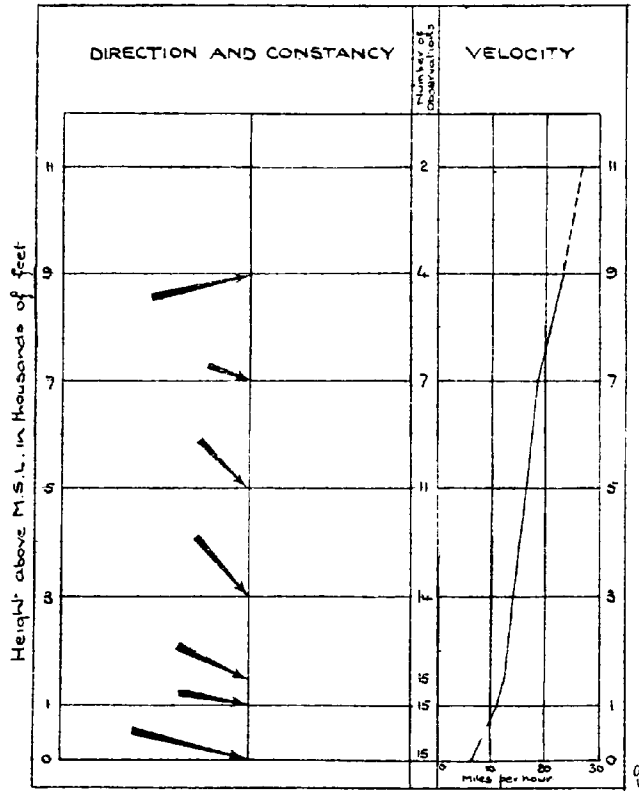
(37755) Wt. 677/393 625 11/37 Hw. G.371 S.O. Code No. 40–57–79



The constancy of the wind is indicated by the length of the direction arrow.

Plate I

FIG. 5 MARCH 1935



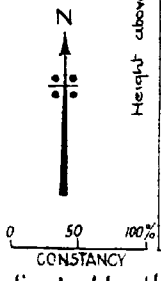
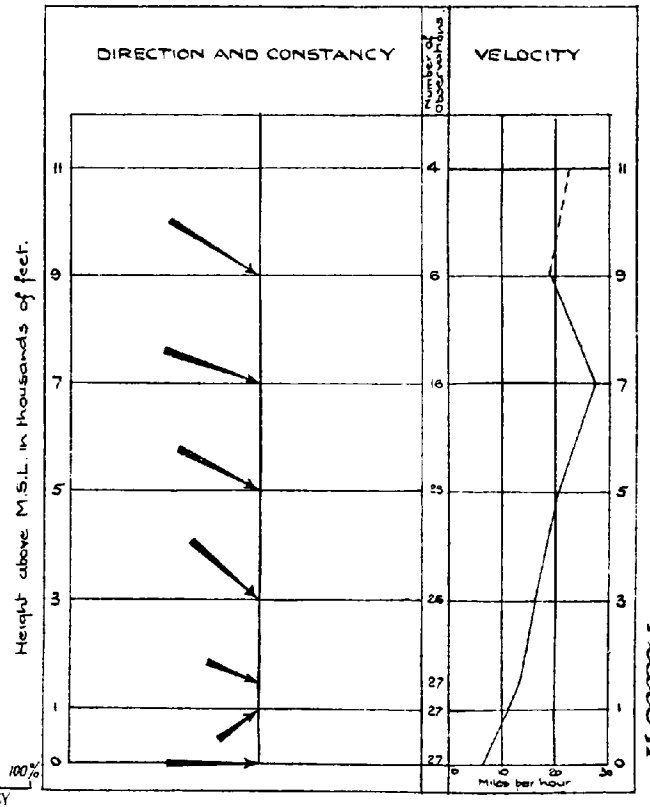
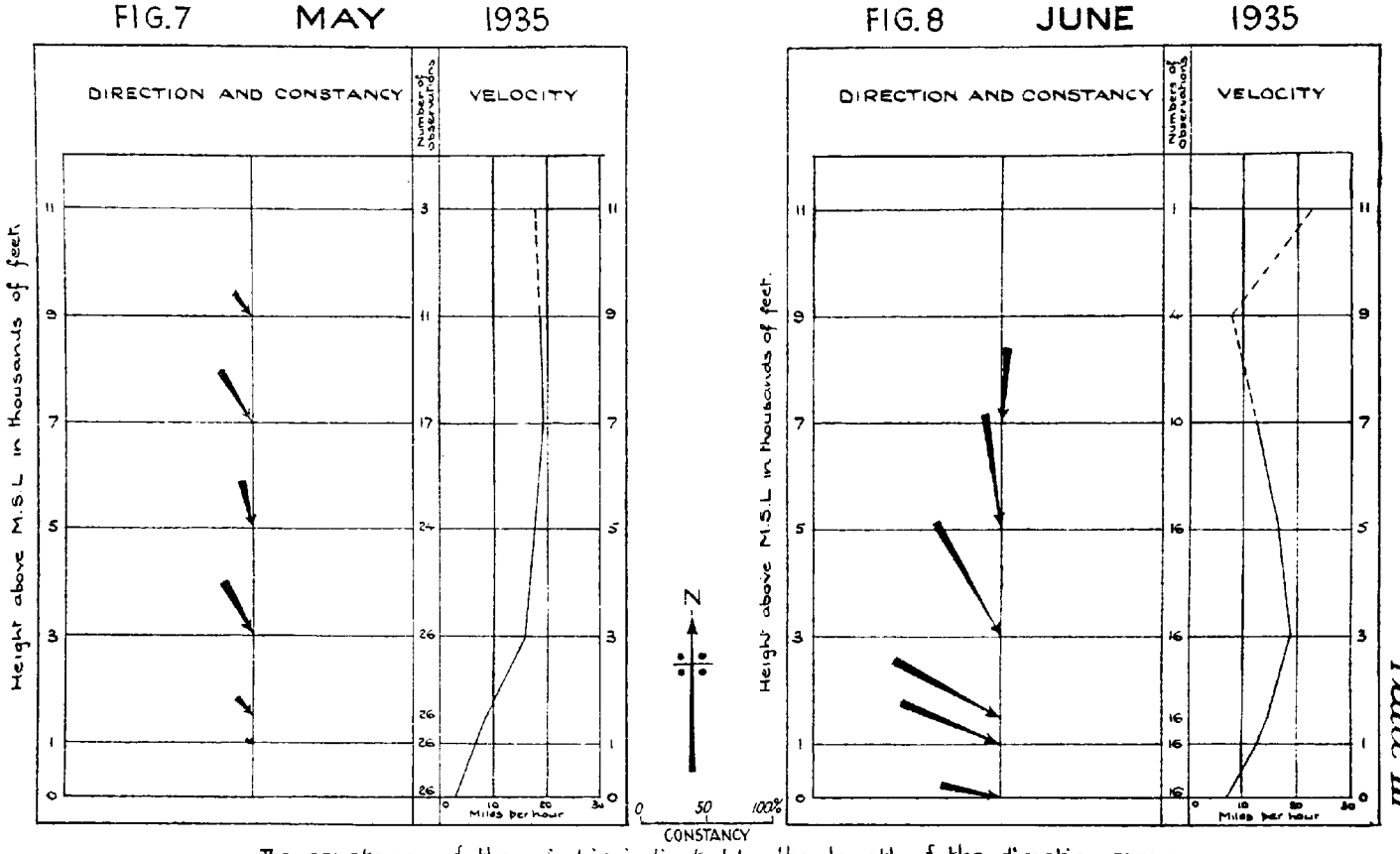


FIG. 6 APRIL 1935



The constancy of the wind is indicated by the length of the direction arrow.

Plate II



The constancy of the wind is indicated by the length of the direction arrow.

Plate III

FIG. 9 JULY 1935

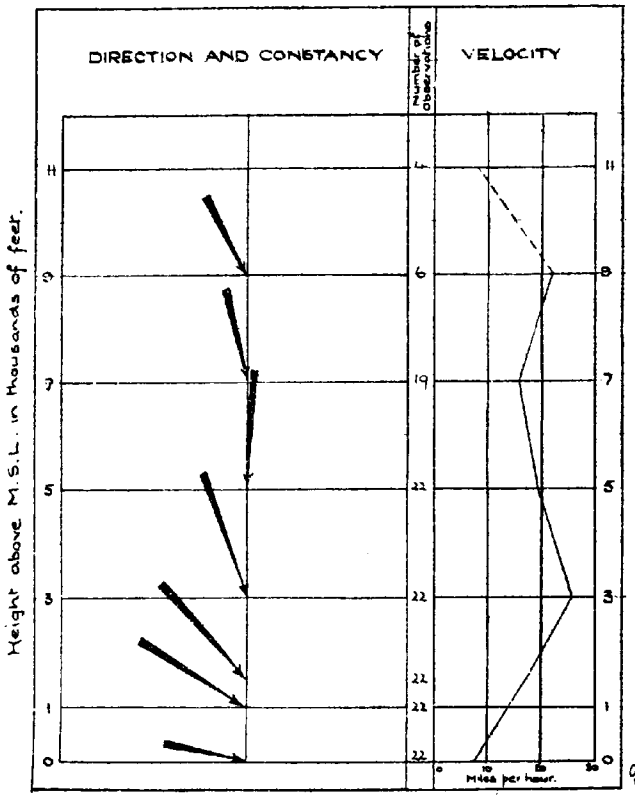
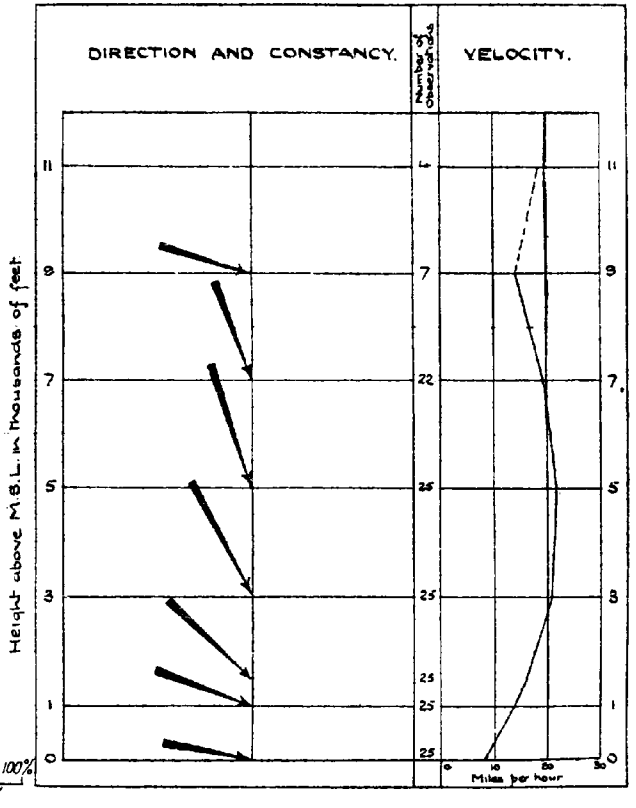


FIG. 10 AUGUST 1935



The constancy of the wind is indicated by the length of the direction arrow.

Plate IV

FIG.11 SEPTEMBER 1934-5

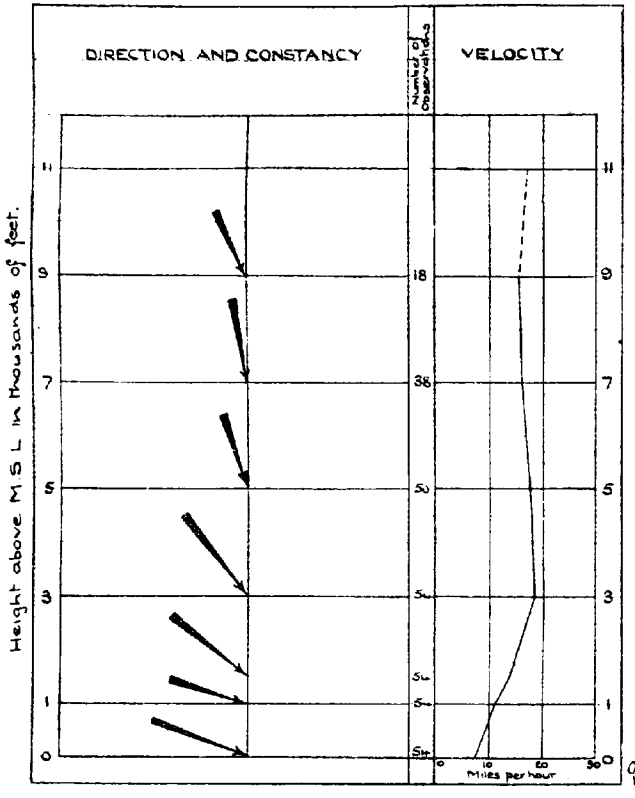
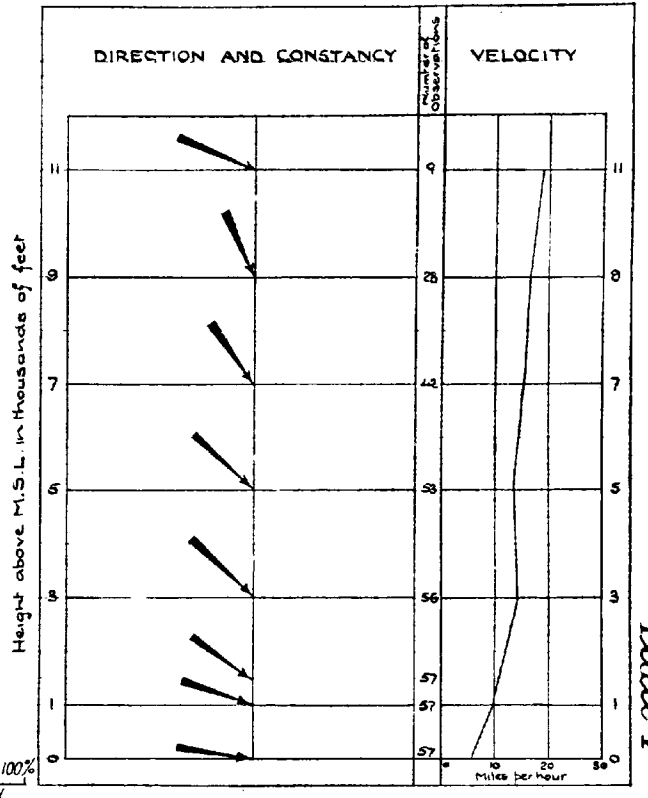
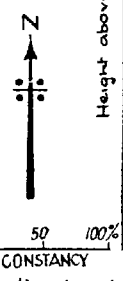


FIG.12 OCTOBER 1934-5

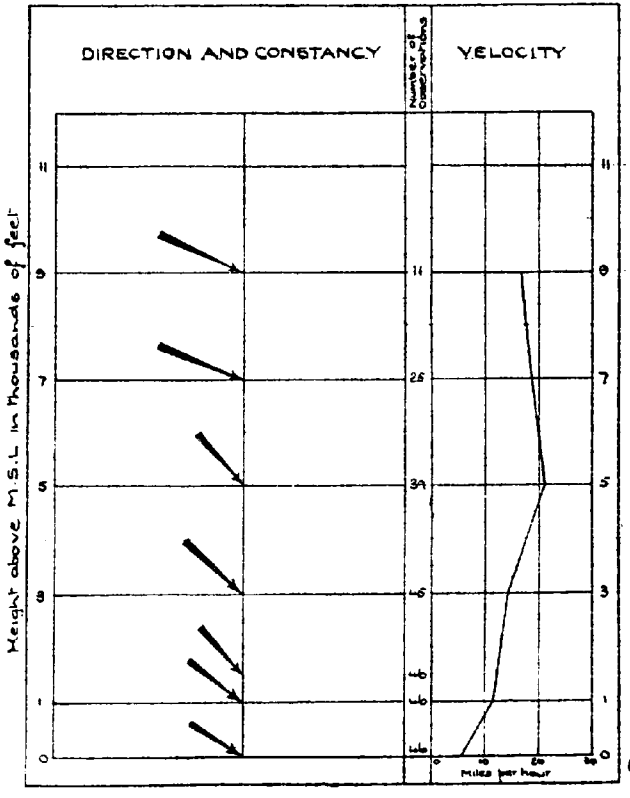




The constancy of the wind is indicated by the length of the direction arrow.

Plate V

FIG. 13 NOVEMBER 1934-5



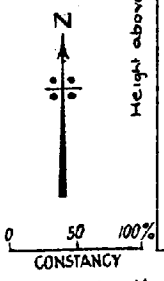
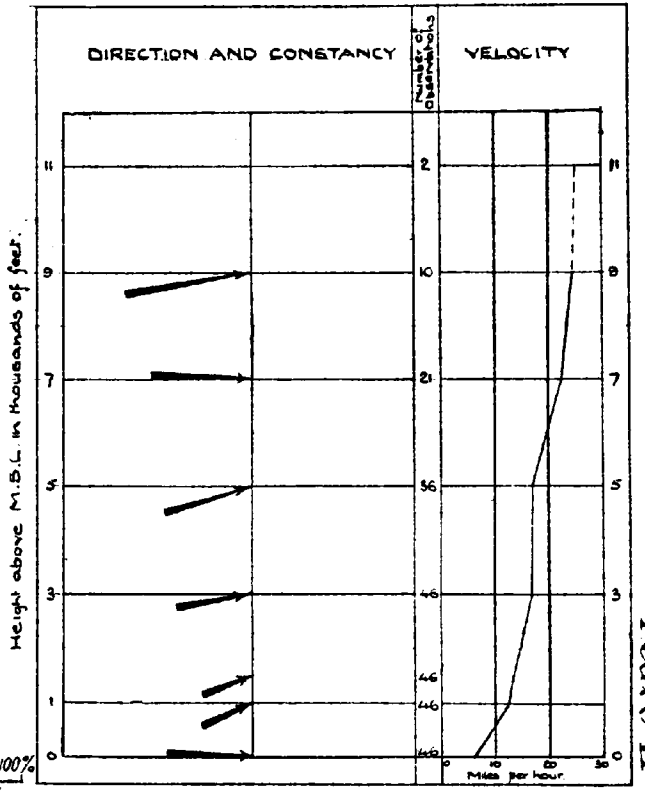


FIG. 14 DECEMBER 1934-5



The constancy of the wind is indicated by the length of the direction arrow.

Plate VI